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EUROGRAM

EUROPEAN OFFICE OF AEROSPACE RESEARCH AND DEVELOPMENT

CC HIGHLIGHTS

EOARD is conducting research in Russia through the International Science and Technology Center. ISTC has announced several additions to its website resources [www.istc.ru/istc/website.nsf/] including the **1999 Annual Report** [www.istc.ru/istc/website.nsf/html/99/english/report.htm], **Public Databases** - new, clear presentation of active or completed projects, and CIS participating institutes [www.istc.ru/istc/website.nsf/fm/ISTC+Database] and a **Search Center** - key word searching for active or completed ISTC projects, activities, and promising research in Russia [www.istc.ru/istc/website.nsf/fm/Search+Center]. These additions were the result of comments from those who use the ISTC website to find the latest information on ISTC activities, scientific talent, and research directions. The ISTC invites you to explore these resources, and provide comments or suggestions via the website or e-mail [istcinfo@istc.ru]

EOARD welcomes Colonel Ron Reed, Permanent Professor and Head of the Department of Biology at the US Air Force Academy. With undergraduate degrees in both Biology and Chemistry from Oklahoma City University and a Ph.D. in Physiology from the University of California, Berkeley, Colonel Reed has served in a number of research-related assignments including Brooks AFB, Andrews AFB, the Pentagon and the Academy (15 years of his 23-year Air Force career). Col Reed has researched laser bioeffects, advanced life support and ejection systems, cockpit automation and virtual world technologies, manned space flight, noise protection, and environmental impacts, and will manage Life Sciences at EOARD.

EOARD hosted Colonel (retired) Bob Mitchell, who was assigned to EOARD while it was still located in Brussels, with 65 staff and eight assigned pilots for ferrying staff around Europe. Oh, the good old days!

EOARD reluctantly says goodbye to Lieutenant Colonel (sel) Jerry Sellers, who leaves us after four amazing years as a Program Manager in Astronautics. Jerry and his wife, Laurie, are heading for the Air Force Academy in Colorado Springs. Jerry will head up the nanosatellite research project in the Faculty of Astronautics at the Academy. Jerry, you will be missed!

Mr. Craig Grand Pre', our associate in the Research and Development Liaison Office (London), passed away peacefully in his sleep at a hospice in suburban London 27 June. A memorial service was held in West Wycombe, England, on 6 July. A small, private family funeral will be held in Chicago. Craig was a friend to all. His approach to living with cancer was truly heroic. We will all miss him.

For the Commander

Robert S. Fredell, Lt Colonel, USAF
Technical Director, EOARD

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Feature Articles

NATO Professional Development Opportunities: Advanced Study Institutes

One way to satisfy annual professional development training requirements and make international contacts at the same time is to participate in a NATO Advanced Study Institute (ASI.) An ASI is a high-level teaching activity where a carefully defined subject, systematically presented, is treated in depth by lecturers of international standing, and new advances in a subject, not taught elsewhere, are reported in tutorial form. A NATO ASI is not intended to be an international conference or symposium, but rather a short course contributing to the dissemination of knowledge and the formation of international scientific contacts. The teaching in ASIs is aimed at scientists at the postdoctoral level with an appropriate scientific background who wish to learn of recent developments in their fields of science. In order to give adequate time for the development of a topic and allow for sufficient scientist interaction, ASIs have a minimum duration of 10 working days. Poster sessions may take place in the evening. While your organization would be expected to pay for your TDY, the ASI itself has no registration/course fee.

As a result of each ASI, a book (published in the NATO Science Series) is produced by the ASI Directors or by an Editor appointed by the Directors in agreement with NATO. It is a textbook written by a team of authors, rather than straightforward proceedings, so that the benefits of the ASI can be extended to other scientists who did not have the opportunity to participate in the ASI.

More information on NATO ASI's can be found at www.nato.int/science/asi.htm.
The latest calendar of scheduled ASI's is at www.nato.int/science/calasi2000.htm

EOARD Hosts Photon-Induced Directional Gamma Emission Workshop

Over the past five years, EOARD and AFRL/DEP have supported a number of activities in induced gamma emission. In 1998, with support from AFOSR and EOARD, Prof. Carl Collins and other European co-investigators conducted a successful experiment to observe the release of energy stored in the nucleus of Hafnium upon being irradiated with 20KeV photons from a dental x-ray machine [1]. A 120x energy gain was observed - a total of 2.4 MeV emitted from the nucleus. This was the first observation of photon-induced gamma emission, an experiment proposed by Collins, et al., in 1979 [2]. This successful experiment is a key result in the induced gamma emission community, so EOARD sponsored the development of a plan of experiments needed to lead to intense, directional gamma emission. The PI on this planning effort was Prof. Lev A. Rivlin of the MIREA Technical University in Moscow, the first person to publish a proposal for a gamma-ray laser [3]. A workshop to discuss this plan and relevant new ideas was held on May 25 and 26 at EOARD. Participating were a distinguished group that included five from Russia, one each from Ukraine, Romania, France, and the UK, and eight from the US (plus three from EOARD).

Prior to the actual workshop, Prof. Rivlin distributed a draft of the plan so that the attendees could review it. The plan consisted of a series of 'road maps' at the 'Federal' (highest) level, the 'Interstate' level, and the 'State' level.

The goal was to determine these 'road maps' for Induced Gamma Emission of Coherent Gamma-rays as a product of Controlled Release and Manipulation of Nuclear Energy Stored in Long-lived Isomers. Demonstrating the richness of R&D in this area, goals other than coherent gamma rays can flow from the controlled release of nuclear energy stored in isomers: (a) energy production, (b) forced emission of noncoherent gamma-ray bursts, (c) coherent optical control of nuclear transitions, and perhaps others.

For induced directional emission of coherent gamma rays, the three key areas of concern are (a) choice of the proper nuclide, its production and separation; (b) development of cooling and trapping of the atomic medium, and (c) development of the pumping process and x-ray sources. Of these the least is known about the cooling and trapping of the atoms and forming them into a linear array hundreds of centimeters long. The attendees did not represent this topic so the break-out groups focused on the other two areas. Each group provided recommendations.

For the choice of nuclide, its production and separation, the 'Nucleus-Photon' Interaction Working Group made the following 'Baseline' recommendations.

(1) Continue 178m2Hf178 triggering activities emphasizing determination of triggering energy level and triggering mechanism, temporal and spectral characterizations of triggered output, and development of independent triggering signatures or approaches to include coincidence measurements, short pulse duration measurements, and other new concepts.
(2) Continue work on the Laser-Mossbauer interaction experiment and ensure an adequate funding level to demonstrate the effectiveness of this approach.
(3) Develop designs for Lu-177 production and triggering experiments, to include all radiological considerations.
(4) Continue the proposed accelerator production of isomer efforts to include analyzing the outputs of all experiments with nuclear production models so as to guide the search for additional isomers.
(5) Perform further study of the isomer chain reaction concept proposed by Prof. Rivlin.
(6) Perform additional experiments to identify and characterize additional "two-level" gamma-ray laser nuclides.
(7) Explore the feasibility of femtosecond pulsed laser production and triggering experiments.
(8) Perform triggering experiments on the 25 day half-life isomer of Hf-179.

This group also offered the following 'High Risk-High Payoff' recommendations.

(1) Investigate and perform femtosecond laser triggering of Hf-178m2.
(2) Perform hohlraum experiments to determine the feasibility of triggering isomers with black-body spectra.

For the development of of the pumping process and x-ray sources, the Sources Working Group recommended:

(1) Use the Argonne National Lab Advanced Photon Source (APS) to do triggering experiments with $\Delta E/E \sim 0.1\%$.
(2) Consider using the Thomson scattering source existing now at Brookhaven National Lab.
(3) Develop a femtosecond laser plasma source for pumping
(4) Develop a compact pulsed x-ray source for triggering isomers.

The entire PIDGE Workshop adopted the following General Conclusions:

(A) Expanded R&D activity on solving the Gamma-Ray Lasing (GRL) problem has the highest recommendations.
(B) This activity should be grounded mostly on the physical concept of the recoil-assisted lasing of free nuclei; alternative reasonable concepts are also to be considered.
(C) The plan submitted by Prof. Rivlin for a set of preliminary investigations (Phase I) should serve as the main guide for the full scale GRL Experiment (Phase II).

References:

[1] C. B. Collins, et al., Phys.Rev. Lett. 82, 695 (1999)
[2] C. B. Collins, et al., J. Appl. Phys. 53, 4645 (1982)
[3] L. A. Rivlin, Inventor's Certificate No. 621265 of 10 Jan. 1961."

PROGRAM MANAGER REPORTS

Col. Gerald O'Connor
Commander

Briefing: Mr. David Pengilley, Thomson-CSF Missile Electronics (TME), 8 June 2000. Europe's leading fuse and missile electronics experts briefed a tri-service group at Edison House. TME traces its history back to WWI days, when Gramophone used its phonograph technology for clock-like artillery fuses. The 400-person facility in Hampshire, UK is carefully segregated from the rest of the international corporation to maintain its UK security approval; only top-level financial data is transmitted to the corporate level. While they perform a variety of legacy work in related technologies, they specialize in target detection devices (TDD) for US and European systems. They were part of the unsuccessful Raytheon bid for the UK AMRAAM and are negotiating to be a secondary source for AMRAAM TDDs. They are also quite proud of their TDD in ASRAAM, which they view as at least half a generation improvement over other fielded systems, and hope to be included in the eventual AIM-9X. They also have virtually all the UK Army and Navy multimode ground-attack fusing business. Their Multi-Function Bomb Fuse was tested under the FCT program in the early 1990's at Eglin Air Force Base, Florida. TME is proud of its status as AFRL's first foreign customer to contract to use AFRL test capability, also at Eglin.

TME has a unique catapult test facility that uses 32 rubber O-rings stretched by a hydraulic ram to accelerate a test fuse into a hard stop at up to 100,000 g's. Unfortunately, the range does not allow targets with extended depth; i.e. to test deep penetrating fuses. Still, TME is essentially a one-stop shop for hard-target smart fuses. They have experience not only in void sensing but also material discrimination, as in a concrete-sand-concrete penetration versus concrete-air-concrete. They are also investigating the ability to have the fuse track in lateral movement during penetration. Based upon pre-launch instructions, material sensing, and lateral-motion sensing, they propose to fuse or safe the weapon. They also are contracting for a small, hardened data-recording device for testing fuses. This capability could help with self-bomb-damage assessment concepts being discussed today.

TME has a number of advanced concepts they are pursuing. As a counter-countermeasure to a future tank hard-kill countermeasure system, they propose to enable the fuse to arm a self-fusing long-rod weapon outside the range of the countermeasure, or if no countermeasure is detected, delay fusing until a more optimum time. They have done some 94-GHz seeker, SAR and ISAR work, and are currently investigating a dual mode 94-GHz seeker coupled with an 8-10 micron IR seeker, as well as investigating passive millimeter-wave (MMW) technology, for airport security, airfield threat warning, and buried landmine detection.

Lt. Col. Rob Fredell
Technical Director

Site Visit: Institute for Problems in Materials Science and Institute for Metal Physics, Kiev, Ukraine, 15 –25 May 2000. A combined AFRL/ML, EOARD and Office of Naval Research (Europe) team including Dr. Dan Miracle and Dr. Kumar Jata (ML) and Dr. Igor Vodyanoy (ONR) traveled to Kyiv, Ukraine on 15-25 May 00. The team visited:

- the Science and Technology Center of Ukraine (STCU), which will provide the contracting mechanism for the AFOSR Metals Initiative in Ukraine
- the E.O. Paton Electric Welding Institute (PEWI),
- the Institute for Metal Physics (IMP), and
- Institute for Problems of Materials Science (IPMS)

The **Science and Technology Center of Ukraine** is a multi-national non-proliferation organization established to encourage the conversion of the weapons-based science and technology in Ukraine to peaceful purposes. Their website [www.stcu.kiev.ua] contains details of their mission and activities. The team met the leadership and management of STCU and discussed the details of the contracting, management and oversight of the programs that will comprise the AFOSR Metals Initiative. Some benefits associated with partnering with STCU include:

- projects receive Ukrainian government approval
- research funds are not taxed by Ukraine
- a maximum overhead of 10% can be levied by the host institute
- payments are made directly to scientists
- Western-style accounting practices are followed
- matching funds for Window on Science visits may be available for Ukrainian scientists

The **Paton Electric Welding Institute (PEWI),** widely regarded as the leading facility in the world for the welding of titanium alloys, is also one of the leading institutes in the world concerned with the joining of materials. PEWI is a participant on two the three

AFOSR Metals Initiative proposals. On this visit, the team assessed the facilities and resources of PEWI for areas of joint interest and discussed the possibility of direct collaboration. Discussions were held with Dr. K. Yushchenko (Deputy Director), Prof. A. Ishchenko (Department Head, Light Metal Welding), Prof. V. Ryabov (Chief, Welding of Dissimilar, Composite and Multilayer Materials), Prof. V. Zamkov (Department Chief, Ti Alloys Welding), and senior scientists Prof. A. Bondarev (Bonding of High Ni Steels) and Dr. V. Savchenko (Weld Repair of High Alloys Steels and Ni Superalloys).

While during the Soviet era, PEWI staffing reached over 9000, it has dropped dramatically to a level of about 3000. Two-thirds of the staff are scientists and engineers with the rest being support staff. Research activity is organized into three technical focus areas.

- Joining of materials with departments that specialize in all major alloy families of engineering significance including Al, Ti, Ni and steels.
- Advanced melting with specific emphasis on electron beam melting and electroslag techniques.
- Surface techniques, which includes studies of oxidation and surface hardening.

The PEWI interacts at three levels;

1) Through direct support of customers through the supply of welding consumables, through the licensing of joining technology (such as for flash butt welding) and through the establishment of new welding techniques and processes,
2) through international S&T organizations such as STCU, INTAS and direct funding from foreign countries, and
3) through joint technology ventures such as with Pratt and Whitney for the physical vapor deposition of thermal barrier coatings on advanced gas turbine blades.

Prof. A. Bondarev presented an array of dissimilar metallic joints including Al/stainless steel tubing joints, Cu/Al joints, and Al/steel roll-bonded joints. All of the joints displayed a strong blend of high technical competence and clever engineering.

Prof. V. Ryabov presented metal matrix composite (MMC) joints including welded joints in continuously-reinforced MMC's (Al reinforced with either B fibers or C fibers), discontinuously-reinforced MMC's, and joints between discontinuous MMC's and unreinforced metals. Discontinuously-reinforced Al/SiC particulate composites were joined to an Al alloy via He arc welding. The melt time and alloy compositions were both controlled to limit reaction of the SiC particulates in the melt zone, and stirring was introduced by an undescribed process to effect mixing of the reinforcements in the fusion zone.

Prof. A. Ishchenko described the development of welding alloys and techniques for Al-Sc alloys performed jointly with scientists at IPMS. Scientists at PEWI develop welding technology and welding alloys, while technologists at IPMS work to develop advanced Al alloys for improved mechanical properties, corrosion resistance and weldability. Laboratory-scale quantities of candidate alloys are produced and tested at IPMS, while larger quantities (ingots up to 10 kg, plate to 0.5 m wide and extrusions) are produced at PEWI. Al-Sc alloys have been developed for welding Al-Li alloys. Up to 0.3-0.5% Sc is added to refine the structure in the weld.

Flash Butt Welding, a process developed, patented and commercialized at the PEWI, is a cost-effective and rapid process that is most attractive for joining large pipes and rails. It is now licensed in Italy, Korea, Canada (the CSX rail company) and the US (the Norfolk Southern rail company). Flash butt welding was used for the entire length of the Siberian pipeline and is widely used for large diameter pipes.

Prof. S. Savchenko described the weld repair of Ni superalloy turbine blades for land-based power and gas turbines. While filler wire of the same alloy composition as the blade is desired, the high strength of these alloys makes the cost-effective production of wire beyond the capability of current technology. Previous weld repairs relied upon IN625 wire. Although it could readily be drawn to wire, it had a welded strength that was often 30% of the strength of the blade alloy. A process using the injection of Ni superalloy powder was developed at PEWI. Powder nearly equivalent to the blade alloy composition can be used to provide higher strength weld repair. This technique is now being used for polycrystalline blades, and efforts to extend this technology to single crystal blades are underway.

Prof. V. Zamkov described the current techniques being developed and utilized at PEWI for the welding of Ti alloys. Electroslag welding utilizes either rod or plate electrodes for very thick welds. Electron beam welding can be used to produce welds up to 400 mm thick in a single pass. MIG welding of butt joints up to 6mm thick in a single pass was demonstrated with the assistance of a flux that was painted on the base metal. TIG welding was stated to be the most acceptable

process of welding for Ti alloys, since it minimized the use of expensive weld wire.

A technique was demonstrated for boring holes in long metal that can bore a 25-mm hole 1 m long in about one hour with a surface finish of the bored hole similar to electo-discharge machining (EDM). The technique was developed elsewhere but is now being applied at PEWI.

The **Institute of Metal Physics (IMP)** was founded about 70 years ago by G. Kurdjumov, and received full institute status in 1955. Five scientific themes are pursued:

- Theoretical Foundations of Metal Physics including the structure and defects of crystals, fault energies and optical properties,
- Electronic Structure and Properties of Metals and Alloys including superconductivity for high current density and high critical superconducting temperature,
- Physics of Strength and Plasticity including efforts on amorphous metals,
- Phase Transformations and Phase Equilibria for transformations near equilibrium but including martensitic transformations, and
- Surface Science.

There are 24 scientific departments and 7 laboratories that conduct the technical program of the institute. While the staff of IMP once reached 1500 (700 support), the current staff numbers about 600 - 150 Ph.D. scientists (53 possess the highest degree, similar to the Doctor of Habilitat in the German system), 150 M.S. and B.S. scientists and about 300 support staff. The decrease is the result of poor economic conditions and the formation of a separate Institute of Magnetism.

A tour of the Display Hall provided a broad sampling of the technological progress. It highlighted innovations in low-alloy/high-nitrogen steels, amorphous metals, Ni-based directionally-solidified eutectic alloys, and refractory metal research. It also presented rapid direct-current heating of steel billets to improve low temperature fracture properties and to enable wire drawing of high strength steels, and specially-built equipment for high temperature differential thermal analysis (up to 2500°C) and X-ray diffraction.

Prof. Ivasishin described the technical activity that will be proposed for the AFOSR Metals Initiative. The broad objective is to support the Ukrainian Ti metal industry by evaluating the primary Ti material produced by electron beam melting and by improving the secondary processing of advanced Ti alloys. The specific approach to improving the secondary processing of Ti alloys is the rapid annealing of Ti sheet. This limits the amount of time that the sheet material is above the beta transus, thereby limiting grain growth. Grain sizes as fine as 0.5 ? m are claimed to be possible with this technique. Few technical details were provided in the discussion.

A brief amount of time was spent with Dr. V. Maslov (Head of Department, Crystallization). While the technical effort emphasizes the magnetic properties of amorphous Fe-based materials, some work on amorphous Al has also been conducted. Two single-roll melt-spinning units were viewed in the laboratory. Both used a water-cooled copper wheel. The smallest had a wheel diameter of about 350 mm diameter, and was enclosed in a vacuum chamber. Wheel speed and ribbon thickness could both be controlled. The melt capacity was about 0.5 kg. The larger wheel was about 500 mm in diameter, and could melt up to 5 kg of Fe alloy. A run was performed while we watched. A high quality surface was produced on two sides, and the ribbon was about 25 mm wide. Some of the material was provided to AFRL/ML for characterization. The larger unit performed melting in air.

Overall, the discussions and tours at IMP gave the impression of a high-quality research institute. While the building facilities clearly suffered from a lack of upkeep, the equipment seemed to be reasonably well maintained, and was typically in use (not always the case in other institutes). The IMP team gave an overall impression of being very knowledgeable.

The visit to the **Institute for Problems of Materials Science (IPMS)** was made to receive a technical update concerning a currently-funded activity on the development of in-situ Ti eutectic composites, and to interact with two research teams that are preparing proposals for the AFOSR Metals Initiative.

A technical activity on the development of discontinuously-reinforced Ti alloys is currently jointly funded at IPMS by AFRL/MLLM and EOARD. The approach of this effort is to explore the influence of higher-order elemental additions to in-situ eutectic Ti-Si-Al-X alloys on the phase equilibria and mechanical properties, and to explore the fundamental phase equilibria in candidate Ti-B-X in-situ eutectic systems. Results from these efforts were presented by Prof. S.

Firstov (Deputy Director) and his research team, and a technical strategy for the final period of performance was discussed.

Prof. Y. Milman (Department Head, Physics of High Strength and Metastable Alloys) described their proposed research project. Six tasks were proposed for this activity, including Sc-modified alloys, amorphous and/or quasicrystalline alloys, and powder alloys of unique composition quenched by water atomization. Some of the facilities were toured, including the melt-spinning apparatus. This team displayed a clear capability in conducting high quality fundamental studies in the areas of interest.

The team provided detailed comments to the principle scientists for guidance on proposal modifications. A number of smaller proposals were also presented and discussed. For more details on IPMS, a previous visit is reported in Eurogram Nov-Dec 99.

Conference: 11th International Conference on Mechanics of Composite Materials, Riga, Latvia, 11 – 15 June 2000, with Dr. Robert Sierakowski (AFRL/MN). The primary hosts were Dr. V. Tamuzs, Dr. Sci. Juris Jansons, Director, Latvian Institute of Polymer Mechanics. [Jansons@pmi.lv]

Since its inception in 1965, this conference on polymer and composite materials has been hosted at Riga, Latvia, at approximately 3-year intervals. The conference included 400+ contributions by authors representing 34 countries. Its scope includes all areas of composite materials science. Two special microsymposia covered textile composites and composites for civil infrastructure. Sessions included five plenary presentations on composite durability, the strength of adhesively bonded fiber matrix joints, the failure of particulate reinforced polymers, and textile composites presented by speakers from the US, UK, Switzerland, and Russia. Afternoon sessions covered durability issues in composite behavior and composite structures issues such as structural optimization and composite damage. A particularly interesting paper was delivered by Dr. Fischer of Ecole Polytechnique Federal Lausanne (Switzerland) on a novel application of 160 tons of mineral particulate reinforced polymers made to repair cracks in an Alpine dam. This technology has possible applications to runway and infrastructure repair.

The remainder of the conference focused on structure and property issues of composites, including material issues in joining of dissimilar materials and properties of organic and inorganic fibers. The first of the microsymposia dealt with applications of advanced composite materials to civil infrastructure. This area has captured considerable interest across Europe as reflected in the range of contributions representing the European presentations and poster presentations.

Later sessions included discussion of papers dealing with the fracture and fatigue of composites as well as numerical methods in composite design, including analytical techniques for evaluating the static, dynamic, and failure of three dimensional textile composites. Prof. Chris Pastore of the University of Philadelphia and Dr. Alexander Bogdanovich and colleagues of 3Tex (USA) were key presenters in this technology area.

The conference concluded with a session on non-destructive testing. Dr. Sci. Vairis Shtrauss [strauss@edi.lv] of the Latvian Institute of Polymer Mechanics presented novel techniques for monitoring and controlling of non-isothermal cure processes. His work uses artificial neural networks to monitor the change in polymer dielectric properties during the cure process to control the process accurately while reducing overall cure time and energy consumption. His efforts have led to a simple, inexpensive hand-held dielectric device that could be used to investigate the cure state of in-situ bonded repairs.

The Director of Institute of Polymer Mechanics, Dr. Sci. Juris Jansons, hosted a tour of the Institute. He included a history of the Institute and the coordinating role it played in all research into polymer composites in the former Soviet Union. The Institute has 40 scientists and engineers with approximately 140 employees, sustained by an annual budget of half a million dollars in direct government support, with additional support coming from European industrial applications of composites to automotive and civil infrastructure applications. In addition to the dielectric cure monitoring work, the Institute's strength continues to be in mathematical modeling of textile (3D woven) and carbon-carbon composites. Some industrial concerns are using the Institute's significant coupon-level test capabilities and taking advantage of their bargain pricing basement (about 2% of US costs).

Meeting: Composite Bonded Repairs, DERA Farnborough, United Kingdom, 21 June 2000. Attended by host Dr Peter Poole, Prof. E. Gdoutos (U. of Thrace, Greece) and Dr. Z. Riga (Hellenic Aerospace Industries), the meeting covered the current status of

the European Union-funded work in composite repair of metal aircraft structures. Though details will not be released outside of the EU for some time, promising results have been found in novel curing and temperature control methods. Additional efforts are being made to develop new surface preparation techniques for in-situ phosphoric acid anodizing. Release of the results can be expected in late 2001.

Meeting: ESEP final outbriefs for class of 2000, Arlington VA, 27/00 – 28 June 2000. Hosted by Mr. John McMann, AFOSR/NI, this was the final meeting for the group of Engineer and Scientist Exchange Program (ESEP) participants who started their overseas exchange assignments in summer 1998. The group included:

- *Captain Paul Blue*, who has been working at DLR Oberpfaffenhofen, Germany, on advanced flight control modeling. Paul will start an AFIT-sponsored Ph.D. program at the U. of Minnesota in early 2001 with a faculty assignment at AFIT to follow.
- *Dr. Victor Burnley,* who has researched turbulence modeling in liquid rocket engines at ONERA Chatillon, near Paris, France. Victor will return to AFRL's Propulsion Directorate in the fall.
- *Captain Phil Cali,* who worked at ONERA's Chatillon facility near Paris, modeled 3-dimensional airflows and developed new computational schemes for efficient finite element analysis. Phil will join the Air Force Test Pilot School in early 2001.
- *Mr. John Corley*, who is working at the Ernst Mach Institute (EMI) in Freiburg, Germany on high-strain rate effects on concrete structures, will continue at EMI for an additional year, earning a Ph.D. before his return to the Munitions Directorate at Eglin AFB.
- *Captain Cindy Klahn,* who worked at the German Flight Test Center at Manching, has joined the Engineering Mechanics faculty at the U.S. Air Force Academy, Colorado Springs CO.
- *Dr. Jim Michels,* who spent a year developing radar algorithms at DERA Malvern, United Kingdom, has re-joined the radar signal processing branch of the Sensors Directorate at Rome, NY.
- *Ms. Denise Shealey*, who is assigned to the German Federal Defense Acquisition Group BWB in Koblenz, Germany as an air-launched missile program manager, will return to the Aeronautical Systems Center at Wright-Patterson AFB, OH.
- *Ms. Kathleen Zyga,* who has worked on synthetic aperture radar and neural networks for pattern recognition at DSTO Adelaide, Australia, will return to the Sensors Directorate at Rome NY.

Dr. Charbel Raffoul
Aeronautics

Representatives from AFOSR, AFRL, the Johns Hopkins University Applied Physics Laboratory (JHU/APL), and EOARD traveled to Moscow and St. Petersburg to visit Russian institutes under contracts with EOARD for advanced aerospace technologies investigated under the Russian Initiative.

Site Visit: High Temperature Institute (IVTAN), Moscow, Russia. The High Temperature Institute (IVTAN) consists of regular academic laboratories, a design bureau, and experimental workshops for design and manufacturing of major facilities and prototypes. The Institute employs 1,500 from a budget provided by the Russian Academy of Sciences, the Russian Science Foundation, and direct contracts with industry.

IVTAN main research involves the study of thermodynamics, transport and optical properties of gases, liquids, solids, and aggregates, especially in the study of their properties at the limiting conditions of high pressures and temperatures. Basic processes are studied in the areas of aerodynamics and hydrodynamics, electrophysics, mass and heat transfer, and chemistry. IVTAN possesses several unique facilities including an on-site capability to use explosives to generate high pressures and temperatures. One of their facilities consists of a 12-m diameter explosion chamber that is capable of handling up to one ton of explosives. They also possess a large wind tunnel for testing heat transfer to full-scale objects. The wind tunnel can generate temperatures up to 3000K, pressures up to 400 atmospheres and mass flows up to 200 kg/s.

Dr. A. Klimov's research is in the general area of plasma, such as plasma aerodynamic wind tunnel tests, combustion enhancement with plasma ionization, the use of plasma generation in noise control, and the generation of extended plasma formations at atmospheric conditions for the absorption and scattering of electromagnetic waves. He has done wind tunnel testing on the F-15 nosecone in the WT-113 tunnel at TsNIIMASH at Mach 1.8. The purpose of the

test was to investigate scaling issues associated with the plasma aerodynamics. Tests were conducted with four types of plasma generators; a high-frequency Tesla coil, a pulse repetitive discharge, AC discharges, and a plasma-jet generator. The best results were obtained with the pulse repetitive discharge using a 4-ms pulse width and repetition rate of between 20 and 100 Hz. A mean drag decrease of 6% was achieved, but the drag decreased by approximately 30% during the pulse. However, since no dynamic force measurement system was described, questions exist concerning this measurement. Dr. Klimov notes that little control over the discharge existed, so a detailed assessment of optimum discharge parameters is not possible at this time. Based on these test results, he believes that a fundamental study of the discharge formation in supersonic flow is required, so that the processes can be better predicted and controlled.

Dr. S. Leonov has performed plasma aerodynamic experiments in wind tunnels, ballistic ranges, and shock tubes for external flow control and drag reduction. He found that the efficiency is higher for bodies with a large drag coefficient - in other words, plasma generation is of little benefit for aerodynamically shaped bodies. However, he claims that high efficiencies can be achieved by tailoring the plasma discharge parameters. Leonov described four different types of shock wave modifications via plasma generation such as shock splitting (two discrete waves), unstable shock motion (unsteady shock position), invisible shocks (shock not seen in flow visualization), and a distortion of the shock shape (due to local plasma production). The best results occurred when the discharge contained streamer-like formations, which allow small areas of intense heating without large overall energy release.

Dr. V. Bityurin's research involves several issues related to magnetohydrodynamic (MHD) gasdynamic control. He is looking into the possibility of using MHD for onboard flight control and the "AYAKS" cycle concept where MHD compression in the inlet has been shown to be advantageous. He states that the two main problems with MHD are the generation of adequate levels of conductivity in the flow and the generation of the magnetic fields greater than 1 Tesla. The conductivity problem can be addressed with the use of e-beams, seeding of the flow, or other means. He suggested that an entire engine be integrated with the MHD system, since the MHD processes can be expected to affect combustor mixing, while noting that strong similarities exist between streamers that exist in MHD flows and in plasma aerodynamic applications.

Test Facilities: Two laboratories house the ST-1 and ST-2 shock tubes used in the work sponsored through a JHU/APL contract. This work involves the fundamental interaction of shock waves with weakly ionized plasma. The ST-2 shock tube is about 10 m long with rectangular cross section. Testing was just beginning in ST-2, but plans included modifying the facility with a 1-m test section capable of producing a half-meter discharge zone. The facility uses a high-speed camera to generate between 3 and 30 frames of 10-15 μs pulses. The IVTAN group plans to measure shock shape, speed, and pressure and density fields.

The ST-1 shock tube is of smaller scale and uses electrodynamic discharge to generate the shock wave. Measurements of the shock characteristics with and without plasma have been accomplished. Spectroscopic measurements of the 2nd positive band of N_2^+ have been used to determine the temperature profile through the shock tube.

A number of small-scale experiments dealing with different types of plasma generators and the effects of plasma generation on noise were viewed. Demonstrations of a plasma generator that operated with propane fuel were conducted. This discharge was created using an HF Tesla coil and propagated into the laboratory at atmospheric conditions. The setup where the aero-acoustic control work was being conducted consisted of a small supersonic jet exhausting into a vacuum tank. A plasma generator was located around the periphery of the jet and could be discharged in a direction nominally parallel to the jet exhaust. Supersonic combustion was demonstrated on a hydrocarbon-fueled scramjet at Mach 6-6.5 conditions under the direction of Dr. V. Vinogradov of CIAM.

One laboratory used to house a small MHD research facility. The facility used a combustor that burned a mixture of alcohol, kerosene, and oxygen to feed the MHD portion of the experiment. IVTAN is planning to use this combustor to generate a jet exhaust that will allow them to investigate the effect of plasma generation on noise reduction at relatively large scale.

IVTAN holds an annual 3-day workshop (usually in March) on "magneto and plasma aerodynamics for aerospace applications" that has helped to better coordinate activities between U.S. and Russian

researchers under encouragement and financial support of EOARD. The proceedings are available in English.

Site Visit: Leninetz Holding Company, St. Petersburg, Russia. The visit to Leninetz began at the State Institute for Applied Chemistry, where Leninetz has conducted an program under EOARD sponsorship to experimentally investigate the second stage of their kerosene-water reforming process in their endothermic reactor test facility. The facility consists of methane and water supply systems, electrical resistance heaters for pre-heating the methane and water, a reactor vessel where the reforming process occurs, and a plasmatron for heating the reactor vessel. The products of the reaction were mixed and burned with the plasmatron airflow downstream of the reactor and then vented through a facility exhaust system. The plasmatron operates at 200 kW and is capable of providing 1 MW/m^2 to the 400-mm long reactor tube. The electrical resistance heaters are capable of preheating the fuel and water streams to between 500°C and 900°C. Outlet temperatures up to 1000°C have been achieved. Measurements include temperature and species distributions along the length of the reactor tube. Both gas chromatography and mass spectroscopy measurements are available.

Testing was controlled from a room located immediately adjacent to the test cell. Most of the controls and outputs were via analog devices including strip charts to monitor temperatures. It was observed that the pre-heater ran red-hot and a blue flame exhausted from the reactor tube, indicating that little hydrocarbon fuel remained unreacted. A typical run required 15-20 minutes operation until a steady-state condition was achieved. Overall run times between several hours and one day were used to investigate both "stable and unstable regimes."

The "AYAKS" vehicle concept work that Leninetz has been involved with is continuing. The main partners were described as St. Petersburg University Physics Department, Academy of Mashinscky for plasma aerodynamics, and the State Institute of Applied Chemistry (for the fuel reforming work). Dr. Kuranov also stated that two articles on the "AYAKS" concept had recently been published in the Russian Journal of Cosmonaut News. Three short talks on "AYAKS" technologies were presented by the principal investigators.

- **Dr. Korabelnikov** provided an overview of his work on the fuel reforming process. He discussed the effects of reactor length and flow velocity on the temperature distributions and degree of chemical conversion. Korabelnikov stated that plasma-sprayed nickel and chrome catalysts had been investigated using the reactor walls. Platinum or palladium may prove to be better catalyst materials but at substantially higher costs.
- **Dr. Sheiken** provided a presentation on the results of his MHD simulations, covering the benefits of the MHD system - added compression, ability to control flow profiles, and the generation of onboard electrical power. He presented calculations showing that the MHD system could generate self-sustaining power using an e-beam ionizer at about Mach-6 conditions. The effects of the MHD was shown to enhance the scramjet performance for power extraction levels below approximately 6% (i.e. up to 6% of the flow total enthalpy could be extracted without a net drop in the scramjet performance). His calculations also showed a large (18-37%) increase in mass flow captured by the inlet when the MHD system was used. This increase in mass flow was attributed to the ability of the MHD system to direct additional flow into the internal portion of the inlet.
- **Dr. Kuchinsky** spoke on the control of aerodynamic parameters, claiming that aerodynamic efficiencies (lift-to-drag ratios) of 4.5-5 were achievable. The approach to producing plasma aerodynamic effects was aimed at generating large temperature gradients that would lead to shock dispersion. He also stated that 70,000-100,000K spectral lines were being produced in special discharges. This mechanism for modifying flowfields was said to work in any flow conditions.

Site Visit: Ioffe Physical Technical Institute, St. Petersburg, Russia. The Ioffe Physical Technical Institute is the largest institute within the Russian Academy of Science. The purpose of the visit was to review progress made on the AFRL contract "Investigation and Perspectives of Gas Flow Control by Magnetic Field." Short presentations on the experimental and analytical activities and tours of the laboratories were provided. Dr. Y. Serov also presented a short summary of his work analyzing plasma aerodynamic phenomena.

Dr. Vasil'eva provided a summary of the experimental program being conducted in a small-shock tube. In this

experiment, rare gases produced heat in the shock tube to conditions where the gas is thermally ionized. A short Mach 4 converging-diverging nozzle was used to expand the flow rapidly, which results in conductive freestream conditions. In the test apparatus, the inlet model is a simple two-dimensional opposed-ramp design constructed from a dielectric material with embedded electrodes. Helmholtz coils embedded in the test section walls are used in generating a pulsed magnetic field. The run time of the facility based on luminescence measurements is 500 μs.

Theoretical predictions of the freestream gas conductivity have been completed for a range of test conditions and different rare gases. Preliminary measurements of the effective gas conductivity have been made using the electrodes built into the inlet model. These measurements show that the effective conductivity is 30-40% of the theoretical values. The testing in the small shock tube appears to be progressing. Follow-on testing will be conducted in the large shock tunnel.

Svetlayna Sushchikh provided a summary of the progress made in the computational portion of the contract work. To date, two-dimensional steady and unsteady and three-dimensional steady CFD codes have been developed to assess the magnetic control of flowfields. The initial versions of the code have assumed inviscid flow and a relatively crude magnetic interaction model. The effects of magnetic field interaction and orientation on the flowfields have been calculated for conditions relevant to the shock tunnel tests. A significant degree of control has been shown in the calculations with deceleration of the flow down to subsonic velocities obtained. The work to be completed under the remainder of the contract includes development of a three-dimensional unsteady CFD code, coupling of Maxwell's equations to the flow equations, improvement of the thermodynamic models employed, and the addition of viscous effects including turbulence to the CFD codes. The results will be presented at the AIAA Plasma Dynamics Conference, in Denver, this summer.

Following the discussion on the MHD control of flows, **Dr. Y. Serov** provided a short summary of his work associated with modeling plasma aerodynamic modeling. The theme of his presentation is that plasma instability result in a strong interaction between charged and neutral particles in the plasma aerodynamic experiments. This so-called ion-acoustic soliton is generated and observed in several experiments. A photograph of a sphere flying through externally generated plasma was shown. A second "bow" shock wave appears in the photograph. Dr. Serov explained that this picture captures an unsteady phenomenon and provides direct evidence of the ion-acoustic soliton.

Dr. A. Schmidt discussed his work on multi-phase flows involving calculation of aerodynamic forces in dusty flows, expansion of multi-phase flows through nozzles, and multi-phase shock calculations.

Test Facilities: The shock tubes (small and large) laboratories where the MHD flow control work is being conducted, were visited. The laboratories appear to rely on older equipment such as film recorders (rather than CCD cameras) and oscilloscopes (rather than automated data acquisition systems). "Ballistic ranges" where the early plasma aerodynamic studies were conducted and a "rail gun" facility were also toured.

Lt. Col. Dave Burns
Astronautics

Conference: Terahertz Sources and Systems—NATO Advanced Research Workshop, Toulouse France, 21-28 June, 2000. This workshop focuses on presenting research and defining the challenges of working in the Terahertz (10^{12} Hz) region of the electromagnetic spectrum. The conference had 63 attendees and more than 40 posters and presentations. Traditional microwave sources and systems function at frequencies up to a few hundred GHz (10^9 Hz), and long wave infrared optical sources and systems can function at frequencies as low as 10 THz (λ = 30 μm). The frequency band between 100 GHz and 10 THz is challenging, but the many applications in this band include high capacity wireless communications, devices for sensing pollution, detection of biological or chemical agents, and medical imaging. The challenge in working in this domain results from the THz region bounding transit time devices (traditional microwave sources) and band gap devices (traditional photonic sources).

Many breakthroughs were reported, and it was obvious that much had been accomplished in the four years since the last workshop. Work on Quantum Cascade (QC) lasers with low frequencies reaching down into the single digit THz region was reported by the University of Neuchatel in Switzerland (Dr Jerome Faist). Semiconductor superlattices were used to generate THz signals by the University of Regensburg (Germany) and

the University of California, Santa Barbara (UCSB). The University of Leeds has begun work on building THz traveling wave tube (TWT) amplifiers using microelectromechanics (MEMS). The breadth of work in the THz region is broad, and more than 20 universities in a dozen countries presented ideas at the conference.

Dr. Christopher Reuter
Information / C4I

Site Visit: Department of Computer Science, University College London (UCL), 16 May 2000. Professor Peter Kirstein, Director of Research for the Networked Multimedia Research Group [www.cs.ucl.ac.uk], hosted the visit. He presented his group's research in developing IP multicast conferencing technologies and applications to support collaborative research, technical development and distance education. The main areas of research include:

- Robust networked audio
- Coordination and control of multicast conferences
- Multimedia servers and video on demand
- Transcoding and gatewaying of media streams
- Secure conferencing systems and infrastructure
- Audio/video quality assessment
- Evaluation of multicast conferencing

Site Visit: Department of Engineering Science, University of Oxford, 26 May 2000. The visit was hosted by Professor J. M. Brady, Professor of Information Engineering, in conjunction with Dr. Ian Reid, Advanced Research Fellow in the Active Vision Laboratory. Both Brady and Reid are part of the Robotics Research Group [www.eng.ox.ac.uk]. The main topic presented was reconstructing three-dimensional structures from two-dimensional images. However, they also presented other research including information engineering, medical vision, pattern and image analysis, intelligent data analysis, signal and image processing. Their research group also works issues in neural computing, machine learning, image and scene geometry, sensor characteristics, robotics and control, and real-time, parallel computing. Applications include visual surveillance, autonomous navigation, and telerobotics. Also in attendance were Dr. M. Varga, Dr. P. Ducksbury, and Dr. M Strens all from DERA.

Major Tim Lawrence
Space Technology

Site Visit: **Nitrous oxide monopropellant system testing, U. of Surrey, Guildford, United Kingdom.** Surrey has begun testing a rhodium-based catalyst in an attempt to increase the working fluid temperature compared to other industry standard type catalysts, i.e., Shell 405. By bringing nitrous oxide to the thrust chamber at a flow rate of 0.2 g/s and a working pressure of 10 bar, then heating the catalysts up to 200 C at a power of 18 W, power was switched off. Keeping the flow conditions the same, the chamber temperature then increased to 1000 C and held there for 70 minutes. Figure 1 shows the test apparatus. This result looks quite promising for small satellite propulsion systems since a specific impulse of 180 seconds can be achieved at a thrust of 1 N. The 48 bar vapor pressure of nitrous oxide allow it to be stored as a liquid and require no expulsion system. Surrey plans on publishing these results in future papers.

Figure 1

Meeting: Final presentation of Tsniimash on 100 W Hall Thrusters, Electric Propulsion Laboratory, Edwards AFB CA, USA. Host, Dr Greg Spanjers, and representatives of Boeing, AFRL/PRRS and Tsniimash attended this meeting to discuss the results on research into low power Thrusted Anode Layer (TAL) thrusters. Tsniimash took their existing T-27 and D-38 thrusters and varied the magnetic field strength and xenon flow rate to see how they would operate at powers from 50 - 150 W. Their conclusion was that 150 W is the smallest the system can operate at high efficiency (30 % - including the cathode). If lower power operation is needed, then a new thruster must be designed. Discussions of possible new research area in high-power TAL operation will be covered in future Eurograms.

Presentation: NASA Breakthrough Propulsion Program, U. of Surrey, Guildford, UK. I spoke to

graduate students on the NASA Breakthrough Propulsion Program as the European representative of the NASA program manager, Mr. Marc Millis, to spur European interest and encourage collaboration. The goal of the program is to discover revolutionary propulsion topics (mainly from the physics community) that will allow space travel over great distances without requiring huge amounts of energy or mass. Seven initiatives---most considering massless propulsion (using energy to project a force instead of mass)---were discussed. Mr. Millis and I will be conducting a tour of various European facilities in September.

Site visit: Escort AFRL/DE personnel to visit U. of Surrey. The visit included a tour of the University of Surrey Microsatellite Program. The DE representatives were conducting a study for US Space Command to determine the current worldwide database of spacecraft in orbit today. Dr Jeff Ward, technical director, gave a presentation on Surrey's history, existing, and future programs. Surrey, considered by many to be a world leader in small spacecraft design, has built 23 spacecraft to date.

Meeting: TechSAT-21 discussions, DERA Space Department, Farnborough, UK. Dr Agee of AFOSR and Commander Richard Blott discussed DERA research into the DERA Satellite Test and Research Vehicle (STRV), ion propulsion, satellite communication protocols, S-band technology, and MEMS applications for satellite attitude determination and control. Commander Blott also gave a tour of the STRV-C and-D spacecraft and the ion propulsion lab. The meeting ended with discussions of possible DERA collaborations in the TechSAT-21 and University Nanosatellite programs.

CONFERENCE SUPPORT

EOARD promotes technical interchange by supporting and co-sponsoring technical workshops and mini-symposia at overseas conferences. We often receive in return proceedings and attendance for one or more Air Force representatives. Air Force R&D personnel attending or considering attending European conferences should contact EOARD for further information. For further details on the conferences below contact the program manager indicated (see footnotes). **Bi-service and tri-service support efforts are in bold print.**

Dates (2000)	*Location*	*Conference/Workshop Title*	*LO*[1]
2 - 15 Jul 00	Lucca, Italy	20th Century Harmonic Analysis www.cs.umb.edu/~asi/analysis2000	CMS
5 - 7 Jul 00	**UMIST, Manchester UK**	**Polymer Fibres 2000**	**RSF**
9 - 15 Jul 00	Novosibirsk, RU	Int'l Conf on Methods of Aerophysical Research	CNR
9 - 14 Jul 00	Queens College, Oxford, UK	Light Emission from Solids, Material Structure and Theory	CR
10 - 12 Jul 00	**Oxford, UK**	**Sixth International Conference on Residual Stress**	**RSF**
10 - 13 Jul 00	**Lisbon, Portugal**	**Tenth Int'l Symp on Applications of Laser Techniques to Fluid Mechanics**	**CNR**
16 - 21 Jul 00	Ecole Nationale Superieure, Bordeaux, France	9th Int'l Workshop on Laser Physics - LPHYS 2000'	CMS
16 - 19 Jul 00	Tomsk, Russia	7th Int'l Symposium on Atmospheric and Ocean Optics	JAH
24 - 27 Jul 00	University of Southampton, UK	7th Int'l Conf on Recent Advances in Structural Dynamics	RSF
30 Jul - 4 Aug 00	Edinburgh, UK	28th Int'l Symposium on Combustion	CNR
8 - 10 Aug 00	**Pretoria, South Africa**	**Int'l Workshop on Multidisciplinary Design Optimization**	**CNR**
21 - 23 Aug 00	Linköping, Sweden	10th European Conf on Cognitive Ergonomics	RSF
21 - 23 Aug 00	St. Petersburg, Russia	Nonresonant Laser- Matter Interaction 10	CMS
27 - 31 Aug 00	Groningen, The Netherlands	European Conf on Visual Perception	GTO
27 Aug - 1 Sep 00	**Harrogate, UK**	**22nd Int'l Congress of Aeronautical Sciences**	**CNR**
28 Aug - 1 Sep 00	**Brijuni island - Croatia**	**Brijuni conference - Important problems for the XXI century**	**JJS**
3 - 4 Sep 00	**Poznan, Poland**	**US/European Celestial Mechanics Workshop**	**TL**

Dates (2000)	*Location*	*Conference/Workshop Title*	*LO*[1]
4 - 7 Sep 00	Bucharest, Romania	6th Conference on Optics: "Romopto 2000"	CMS
11 - 14 Sep 00	Barcelona, Spain	COMPLAS 2000 Computational Plasticity: Fundamentals & Applications	RSF
11 - 13 Sep 00	Oxford, England	Microwave Photonics 2000	DMB
11 - 14 Sep 00	Barcelona, Spain	European Congress on Computational Methods in Applied Sciences and Engineering	CNR
11 - 15 Sep 00	**Split, Croatia**	**36th Int'l Applied Military Psychology Symposium**	**RSF**
12 - 15 Sep 00	Kharkov, Ukraine	Int'l Conf on Mathematical Methods in Electromagnetic Theory	CR
17 - 19 Sep 00	Gunzburg Germany	10th European Heterostructure Technology Workshop	CR
18 - 22 Sep 00	Zvenigorod, Russia	4th Int'l Workshop on Microwave Discharges: Fundamental and Applications	CNR
18 - 25 Sep 00	Oxford, England	Int'l Workshop on Materials Modeling	RSF
18 - 22 Sep 00	Florence, Italy	XIII Int'l Symp on Gas Flow & Chemical Lasers and High Power Laser Conference	CMS
18 - 22 Sep 00	Katseveli-town, Crimea, Ukraine	Materials and Coatings for Extreme Environments Performance	RSF
20 - 22 Sep 00	Kiev, Ukraine	Organized Vortical Motion as a Basis for Boundary-Layer Control	CNR
24 Sep - 3 Oct 00	Yerevan, Armenia	Cellular Mechanism of Beneficial and Harmful Effects of Electromagnetic Fields	CMS
25 - 27 Sep 00	**Pisa, Italy**	**Condition-Based Maintenance for Highly Engineered Systems**	**RSF**
27 - 29 Sep 00	Amsterdam, the Netherlands	How eye movements serve the needs of vision in the natural world	GTO
2 - 6 Oct 00	Crimea, Ukraine	Singular Optics: Fundamentals & Applications	CMS
9 - 13 Oct 00	Zakopane, Poland	Int'l Conf. On Solid State Crystals - Materials Science and Applications	CMS
16 - 18 Oct 00	**Cranfield, UK**	**Medical and Engineering Aspects of Dynamic Head and Neck Injuries**	**RSF**
25 - 27 Oct 00	Leganes-Madrid, Spain	Learning 2000	CR
11 - 12 Dec 00	**Birmingham, UK**	**Titanium Alloys at Elevated Temperature**	**RSF**
16 - 20 May 01	St. Petersburg, Russia	Mathematical Methods, Models and Architectures for Computer Networks Security	CR
20 - 25 May 01	Capri, Italy	Optimization in Composite Material Design and Structural Integrity	RSF
16 - 20 Jul 01	University of Huddersfield	Algorithms for Approximation IV	CR
24 Sep - 3 Oct 00	Yerevan, Armenia	"Cellular Mechanism of Beneficial and Harmful Effects of Electromagnetic Fields"	CMS
25 - 27 Sep 00	Pisa, Italy	Condition-Based Maintenance for Highly Engineered Systems	RSF
27 - 29 Sep 00	Amsterdam	How eye movements serve the needs of vision in the natural world	GTO
2 - 6 Oct 00	Crimea, Ukraine	Singular Optics: Fundamentals & Applications	CMS
9 - 13 Oct 00	Zakopane, Poland	Int'l Conf. On Solid State Crystals - Materials Science and Applications	CMS
16 - 18 Oct 00	**Cranfield, UK**	**Medical and Engineering Aspects of Dynamic Head and Neck Injuries**	**RR**
11 - 12 Dec 00	**Birmingham, UK**	**Titanium Alloys at Elevated Temperature www.materials.org.uk**	**RSF**
20 - 25 May 01	Capri, Italy	Optimization in Composite Material Design and Structural Integrity	RSF

[1] CMS-Martin Stickley; CNR-Charbel N. Raffoul; CR-Chris Reuter; DMB- David M. Burns; GTO-Gerald T. O'Connor; JAH-Jay A. Howland; JJS-Jerry J. Sellers; RR- Ron Reed; RSF- Robert S. Fredell; TL-Tim Lawrence

WINDOW ON SCIENCE

EOARD initiates and promotes technical liaison between Air Force and foreign scientists very effectively with the Window On Science (WOS) program, through which we can arrange and fund visits of foreign scientists to selected Air Force facilities. To nominate a WOS candidate, contact your Technical Director or your EOARD discipline representative. WOS visitors currently on contract are listed below. For further details contact the program manager indicated (see footnotes). **Bi-service and tri-service coordinated visits are in bold print.**

Dates (1999)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit*[1]	*LO*[2]
3 - 27 Jul 00	**Prof. Edward David Thomas Atkins**	**United Kingdom**	**Structures of monodisperse nylon 6 oligomers**	**St. Paul, MN and WPAFB, OH.**	CR
13 - 22 Jul 00	**Dr. Mohammed Habiballah**	**France**	**Liquid Rocket Propulsion; Cryogenic Propellant Combustion; Combustion Instability**	**Edwards AFB; Huntsville, AL**	CNR
15 - 22 Jul 00	Dr Vladimir Ionkine	Russia	Nuclear propulsion	Joint Propulsion Conference, Huntsville, AL, MSFC	**CMS**
15 - 21 Jul 00	Assoc. Professor Eva Acosta Plaza	Spain	Curvature sensing for retrieving turbulence-induced phase distortions	AFRL/DEBS, Kirtland AFB, NM	DMB
15 - 22 Jul 00	Dr Valeri Iaryguine	Russia	Nuclear propulsion	Joint Propulsion Conference, Huntsville, AL, MSFC	JJS
16 - 20 Jul 00	**Dr. Marwan Darwish**	**Lebanon**	**Computational Fluid Dynamics (CFD)**	**Huntsville, AL**	CNR
16 - 27 Jul 00	**Professor Ioannis Hardalupas**	**United Kingdom**	**Combustion**	**Edwards AFB, Wright Patterson AFB, NASA Glenn**	**CNR**
19 Jul - 14 Aug 00	**Dr. Nina Yurchenko**	**Ukraine**	**Optimal Flow Control Based on Excitation of Inherent Coherent Vortices**	**AFRL/PRTT (WPAFB, OH); Arizona State U.**	**CNR**
20 - 31 Jul 00	Dr. Christian F Riekel	France	Sychrontron radiation studies on spider silk	St. Paul, MN and **Wright-Patterson** AFB, OH	CMS
22 - 25 Jul 00	**Dr. Arvind Jasuja**	**United Kingdom**	**Fuel Sprays, Ignition and Combustion**	**Wright-Patterson AFB (AFRL/PR)**	**CNR**
28 Jul - 9 Aug 00	**Dr. Serguei Dimakov**	**Russia**	**Pre-shaped membranes for large primary mirrors.**	**SPIE Meeting, San Diego, CA and AFRL/DEBS, Kirtland AFB, NM**	**CMS**
28 Jul - 9 Aug 00	**Dr. Vladimir A. Berenberg**	**Russia**	**Optically-addressed spatial light modulators**	**San Diego, CA and Kirtland AFB, NM**	**CMS**
28 Jul - 9 Aug 00	**Mr. Vladimir Venediktov**	**Russia**	**Dynamic correction of large optics**	**SPIE Meeting, San Diego, CA and AFRL/DEBS, Kirtland AFB, NM**	**CMS**
29 Jul - 21 Aug 00	Dr. Adrian Stern	Israel	Restoring images degraded by motion	AFRL/DEBS, Kirtland AFB, NM., and San Diego, CA.	CMS
30 Jul - 10 Aug 00	Ms. Shirly Winnikamien-Pinhasi	Israel	High resolution optical curvature sensing	SPIE in San Diego, CA and AFRL/DEBS, Kirtland AFB, NM	CMS
31 Jul - 19 Aug 00	**Dr. Krzysztof Haman**	**Poland**	**Radar Propagation**	**Idaho Falls, ID Reno Nevada**	**TL**
8 - 16 Aug 00	Professor Kurt Jensen	Denmark	Simulation-Based Acq. - Hierarchical color petri nets	Hanscom AFB MA, George Mason U, Fairfax, VA.	CR
12 Aug - 16 Sep 00	Dr Petr V Sushko	United Kingdom	radiation induced defects in SiO2	AFRL/VS, Kirtland AFB, NM; Sandia National Lab, NM, Uni of NM, Pacific Northwest Lab, WA	JJS

Dates (1999)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit*[1]	*LO*[2]
12 - 19 Aug 00	Dr Alexander Shlyuger	United Kingdom	radiation induced defects in SiO2	AFRL/VS, Kirtland AFB, NM; Sandia National Lab, NM, Uni of NM, Pacific Northwest Lab, WA	JJS
14 - 25 Aug 00	**Professor Terence Jones**	**United Kingdom**	**Turbomachinery**	**AFRL/PRTT; NASA Glenn; Minnowbrook NY.**	**CNR**
15 - 24 Aug 00	Professor Raphael D Levine	Israel	Atmospheric modeling	Hanscom Research Site, MA	TL
15 Aug - 4 Sep 00	Prof. Sol Bodner	Israel	Development of an Engineering Approach to a Unified Plasticity Theory	International Mechanics Conference, Chicago, IL	RSF
18 Aug - 10 Sep 00	Dr. Mindaugas Dagys	Lithuania	High-Power Microwaves	Texas-Tech University, New Mexico University, Army Research Office.	DMB
18 - 25 Aug 00	Mr. Vadim A Zakirov	United Kingdom	Nitrous Oxide Monopropellant Rocket Thrusters for Small Satellite Application	12th AIAA/USU Small Satellite Conference, Logan, Utah, USA	TL
18 Aug - 10 Sep 00	Dr Zilvinas Kancleris	Lithuania	High-Power Microwaves	Texas-Tech University, New Mexico University, Army Research Office.	DMB
19 - 23 Aug 00	**Prof. Erik Dick**	**Belgium**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 27 Aug 00	**Professor Jonathan Gostelow**	**United Kingdom**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 23 Aug 00	**Dr. Vassilios Theofilis**	**Germany**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 23 Aug 00	**Professor Ricardo Fernando Martinez Botas Mateo**	**United Kingdom**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 23 Aug 00	**Professor Frank Smith**	**United Kingdom**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 23 Aug 00	**Dr. Johan Steelant**	**The Netherlands**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 24 Aug 00	**Professor Torsten H Fransson**	**Sweden**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 24 Aug 00	**Prof. Ian Poll**	**United Kingdom**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 23 Aug 00	**Dr. Howard Hodson**	**United Kingdom**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
19 - 23 Aug 00	**Dr. Mark Wyatt Johnson**	**United Kingdom**	**Boundary Layer Transition &**	**Minnowbrook, NY**	**CNR**

Dates (1999)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit*[1]	*LO*[2]
			Turbomachinery Flows		
19 - 23 Aug 00	**Dr. Odayarkoil Natarajan Ramesh**	**United Kingdom**	**Boundary Layer Transition & Turbomachinery Flows**	**Minnowbrook, NY**	**CNR**
20 - 27 Aug 00	Dr Leonid Chernyshev	Ukraine	Porous materials, Tribological props magnetron sputtered films	AFRL/MLBT, Dayton OH	RSF
20 - 25 Aug 00	Dipl.-Ing. Stephan R Ullmann	Germany	Small Satellite design, composite structures for small satellite application	12th AIAA/USU Small Satellite Conference, Logan, Utah.	TL
20 - 27 Aug 00	Dr. Oleksiy Onopriyenko	Ukraine	Porous materials, Tribological properties of sputtered films	AFRL/MLBT, Dayton OH	RSF
20 - 25 Aug 00	Dipl.-Ing. Tim Pühlhofer	Germany	Small Satellite design, composite structures for small satellite application	12th AIAA/USU Small Satellite Conference, Logan, Utah.	TL
30 Aug - 9 Sep 00	Dr. Afzal Suleman	Portugal	Adaptive materials for aerodynamic flutter supression	AFRL/VA, Wright-Patterson AFB, OH	JJS
3 - 9 Sep 00	Dr. Michael Oschwald	Germany	Liquid Chemical Combustion Engine Design and Test Diagnostics	Edwards AFB, CA	TL
4 - 10 Sep 00	Professor Friedrich U vonZahn	Germany	Optical Remote Sensing	Hanscom Research Site, MA	TL
9 - 19 Sep 00	Dr. Svitlana V Berdyugina	Finland	Astronomy and space environment characterization	AFRL VSBS, Sunspot, NM.	TL
9 - 16 Sep 00	Dr. Christopher J. Solomon	United Kingdom	Modeling adaptive optics systems	AFRL/DEBS, Kirtland AFB, NM	CMS
10 - 21 Sep 00	Dr. Shlomo Arnon	Israel	Laser satellite communication networks	AFRL/DE, Kirtland AFB, NM and AFRL/IF, Rome, NY.	CR
10 - 23 Sep 00	Professor Alexey Ustinov	Germany	Applied Superconductivity	Hanscom Research Site, MA, MIT, NRL, Applied Superconductivity Conference, Virginia Beach	CR
12 - 19 Sep 00	Dr. Nadejda Kiselyova	Russia	Modeling of inorganic materials	Inorganic Materials Conference, Santa Barbara, CA., AFRL/ML Wright-Patterson AFB, OH	RSF
16 - 29 Sep 00	Associate Professor Hamid Reza Kokabi	France	Dr Kokabi presents latest research results on superconductivity; Possible year long sabbatical visit	1. Applied Superconductivity Conf -- Virginia Beach, VA (17-22 SEP) ; 2. Hanscom Research Site (24-27 SEP) ; 3. AFOSR Headquarters-- Washington DC (28 SEP)	DMB
23 - 28 Sep 00	Dr Lambertus Sluys	The Netherlands	Modeling of concrete under high strain rates	AFRL/MN, Eglin AFB	RSF
23 - 27 Sep 00	Dr Ir Jakob Weerheijm	The Netherlands	Modeling of concrete under high strain rates	AFRL/MN, Eglin AFB	RSF
26 - 30 Sep 00	Dr. Vladimir Kim	Russia	Low Power Stationary Plasma Thrusters (SPT-17 and SPT-20)	USAF Academy, Colorado; Edwards AFB, California.	TL
26 - 30 Sep 00	Dr. Boris Arkhipov	Russia	Low Power Stationary Plasma Thrusters (SPT-17 and SPT-20)	USAF Academy, Colorado; Edwards AFB, California.	TL
26 - 30 Sep 00	Dr Vladimir Murashko	Russia	Low Power Stationary Plasma Thrusters (SPT-	USAF Academy, Colorado; Edwards AFB, California.	TL

Dates (1999)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit*[1]	*LO*[2]
			17 and SPT-20)		
30 Sep - 5 Oct 00	Dr. Nadejda Kiselyova	Russia	Materials Modeling	Artificial Intelligence in Real Time Control 2000 Conference, Budapest, Hungary	RSF
7 - 14 Oct 00	Professor Francois Kajzar	France	Light and E-field induced movement of molecular subunits in rotaxanes	AFRL/VSSE, Kirtland AFB, NM, USAF Academy, CO, and SUNY Buffalo, NY	CMS
8 - 27 Oct 00	**Professor John Peter Fielding**	**United Kingdom**	**Aircraft Conceptual Preliminary Design**	**AFRL/VASD; AIAA/SAE World Aviation Congress at San Diego**	**CNR**
18 - 22 Oct 00	Dipl. Ing Walter Volker Fleck	France	Magnetic sensors for munitions applications	AFRL/MN, Eglin AFB, FL	CNR

[1] AFRL Research Sites–**ARS**: Armstrong Research Site, Brooks AFB, TX; **ERS**, Edwards Research Site, Edwards AFB, CA **HRS**: Hanscom Research Site, Hanscom AFB, MA; **PRS**: Philips Research Site, Kirtland AFB, NM; **RRS**, Rome Research Site, Rome, NY; **WRS**: Wright Research Site, Wright-Patterson AFB, OH; Other sites: **AEDC**: Arnold Engineering Development Center, Arnold AFB, TN; **USAFA**: Air Force Academy, Colorado Springs, CO; **ARL**: Army Research Laboratory

[2] CMS-Martin Stickley; CNR-Charbel N. Raffoul; CR-Chris Reuter; DMB-David M. Burns; GTO-Gerald T. O'Connor; JAH-Jay A. Howland; JJS-Jerry J. Sellers; PJO-Peter J. Ouzts; RR-Ron Reed; RSF-Robert S. Fredell; TL-Tim Lawrence

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